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POLICY BRIEF

Institutional alignment in the knowledge economy: lessons from Square Kilometre Array telescope

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The Labour Market Intelligence Research Partnership

The Labour Market Intelligence Partnership is a collaboration between the Department of Higher Education and Training and a national research consortium, led by the HSRC. It aims to provide analytical insights which support the development of policies and intervention programmes across the education and training, skills, and employment systems. One component of this research programme is focussed on 'interactive capabilities', that is, the capacity to form effective linkages with other organisations in order to support learning and accumulation of new knowledge (Malerba, 2005; von Tunzelmann, 2010). Case studies were undertaken in three sectors, one of which was the astronomy sector, with a focus on the Square Kilometre Array telescope (SKA). More than seventy interviews were conducted with key astronomy stakeholders, including senior scientists and managers within universities, Vocational Education and Training (VET) colleges, government departments and agencies, firms, the SKA, and other astronomy organisations. The SKA case study (Gastrow, 2015), which forms the basis for this policy brief, explores the interactive capabilities present within the astronomy sector and the SKA's innovation system, and how this has impacted on the alignment of skills supply and skills demand for the project.

Interactive capabilities and the SKA

The Square Kilometre Array (SKA) telescope is a large radio telescope, currently in the design phase, which will ultimately consist of a network of 3 000 large radio receiver dishes and tens of thousands of smaller receivers. It will be built mostly in South Africa, with components in eight African partner countries, as well as Australia and New Zealand. This project is evolving into an apex institution within the South African innovation system, and is becoming emblematic of South African achievement in science and technology. As a consequence, it has benefitted from high levels of political support, which have been manifested in

generous public funding and institutional support. The SKA also forms a global innovation network, with universities, research institutes, science facilities, firms, and government agencies from eleven SKA partner countries collaborating to develop the advanced technologies required to design and build the telescope. The South African component of the SKA has successfully aligned itself, operationally and strategically, with knowledge producing institutions such as universities, research institutes, and engineering firms. It thus presents a suitable case study for understanding interactive capabilities.

The knowledge challenges and skills needs faced by the SKA are extraordinary – including demands at the top the skills spectrum in the domains of astronomy, physics, cosmology, engineering, ICTs, and management, and extending to artisanal and vocational skills required for site infrastructure. Due to visa constraints, importing these skills remains a bottleneck, and overall an impediment to the functioning of the SKA. Moreover, the SKA's skills requirements exist in the context of severe inequality in South Africa's economic and education systems. The focus, therefore, has been on identifying and working with pockets of excellence where resources, networks, and skills are concentrated. By aligning niche areas of expertise with the skills and knowledge requirements of the South African SKA, it has become possible to attain the critical mass and knowledge intensity to successfully bid for the site infrastructure, and to proceed with the demanding science and engineering aspects of the project.

The SKA deploys a range of strategies and mechanisms for facilitating interactions with its knowledge partners. The most important of these is the Human Capital Development Programme (HCDP), a publically funded skills development and research programme that between 2005 and 2014 awarded approximately 600 bursaries, grants, and fellowships. This programme manages the structures and mechanisms through which the skills needs of the SKA are assessed, including foresight exercises, through continuous engagement with scientists, engineers, and management. It then engages with education institutions to strengthen their capacity to develop these skills. These roles are inherently dynamic, as technologies are rapidly developing, skills demands for the SKA rapidly growing, and higher education capabilities constantly evolving.

HCDP administrators monitor bursary recipients and research positions supported by the programme, and maintain control over the range of disciplines, skills, and research foci that are covered. Decisions about the distribution of funding are taken through intensive interaction with scientists and engineers, both within universities and within the SKA itself. Engagement with universities also takes places through an informal Universities Working Group, which provides a less structured forum for interaction. Personal relationships and networks are critical – as precursors to formal interaction, as efficient communication 'short cuts', and as channels for the exchange of tacit knowledge.

The main university partners of the SKA include South Africa's leading research universities, drawing on all the substantial pockets of excellence relevant to astronomy and related engineering and ICT that are distributed across the higher education system. These niches have been highly responsive to the changing needs of the astronomy sector and the SKA: new curricula and courses have been developed, postgraduate research has been aligned with the future needs of the SKA, centres of astronomy science and engineering research have expanded in line with the future requirements of the SKA, and strong informal relationships have been built with the SKA, as well as other actors in its innovation network, such as firms and science facilities. The strong interactive capabilities present at these universities thus are critical to the SKA's innovation network. On the other hand, change in the undergraduate curricula is reportedly too slow to keep up with the requirements of the SKA, particular in rapidly changing fields such as ICT.

Universities also play important intermediary roles. One example is the National Astrophysics and Space Science Programme (NASSP), a nationally co-ordinated postgraduate programme based at UCT, but

including teaching and supervision from all the universities active in astronomy in South Africa. Through this the NASSP aims to make the most of South Africa's uneven and fragmented competences and capabilities in the space science and astronomy domains. The NASSP steering committee, and the structure that determines its curriculum, include both SKA representatives and university academics, and are therefore important fora for these actors to create alignment and inform curriculum development that meets future skills requirements.

The structure and characteristics of interactive capabilities differ across academic disciplines and research fields. In astronomy, interactive capabilities are largely vested within individual academics and at the Departmental level. In Engineering, Faculty structures are critical, and provide examples of good practice in terms of responsiveness to the requirements of the workplace, including close relationships to the engineering professional body, and the encouragement of direct interaction with employers. For example, the provision of one day per week for engineering academics to work externally has made it possible for academics at a leading research university to consult for firms in the SKA's innovation network and supply chain. This has also allowed them to form their own start-ups, often in partnership with postgraduate students or postdoctoral fellows, to participate in these networks and contribute to the SKA's technology development efforts.

Over the course of several years, the SKA has also engaged with Technical and Vocational Education and Training (TVET) colleges, in order to boost the availability of relevant mid-level and artisanal skills. However, due to limited basic competences at the colleges there have been few graduates produced from this interaction. Colleges have limited capacities to internalise planning and specific skills requirements. This is a reflection of South Africa's TVET system, which has been challenged by multiple policy changes, low levels of independence, and weak overall capabilities. However, the SKA has continued to engage with colleges in order to build internal competences and capabilities, and this is leading to a gradual improvement in the quantity and quality of TVET graduates.

The rich and complex system of interactions that co-ordinates alignment between skills demand and skills supply has connected and leveraged existing competences, and orientated them towards the production of skills needed by the SKA. The case of the SKA reveals how, in highly unequal developing countries such as South Africa, interactive capabilities form a lever for access to the global science and technology frontier.

Policy recommendations:

1. If the SKA's model of interactive capabilities and mechanisms is to be replicated in other knowledge intensive projects and sectors, the principal actors, both public and private, would need to provide substantial funding support, high-level political support, and strong coordination mechanisms amongst relevant actors and stakeholders
2. The Department of Higher Education and training should consider how to improve the pace of curriculum change at the undergraduate level, to be more responsive to the knowledge requirements and demands in rapidly evolving knowledge-intensive, high-technology sectors
3. Policy must target and support the development of network mechanisms rather than market mechanisms to align skills supply and demand in smaller and more specialised knowledge intensive sectors. Individual networks for interaction and engagement are critical in the allocation of resources in these sectors.
4. Niche sectors compete for skills and knowledge at a global level. The Department of Home Affairs should improve the efficacy of its visa regime and streamline processes to ensure that high and scarce skills needs are met through visa allocations in the short- to medium-term.

5. The mechanisms and structures that facilitate interaction and engagement in the SKA, such as the HCDP, should inform DST's other niche sectoral strategies, such as in biotechnology, space science and paleosciences. This would enhance interactive capabilities in these sectors to support better alignment of skills supply and demand.

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